IOWA STATE UNIVERSITY

Plant Sciences Institute UPDATE

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From the director

What a splendid celebration! We recently celebrated the groundbreaking for the Roy J. Carver Co-Laboratory and shared with the World Food Prize in honoring those who have made significant contributions in alleviating world hunger.

The Roy J. Carver Co-Laboratory will be the administrative home of the Plant Sciences Institute and embodies a new concept in partnering academia and industry in plant research. We are especially grateful to the Roy J. Carver Trust whose generous contribution made the co-laboratory concept a reality. We are also grateful to many other contributors, including Pioneer Hi-Bred International who endowed the Pioneer Hi-Bred Genomics Laboratory.

The groundbreaking celebration gave us occasion to join with the World Food Prize in recognizing the great leaders of our times whose work has impacted world food production. This year, the World Food Prize laureate is Dr. Per Pinstrup-Andersen of the International Food Policy Research Institute, who contributed to the improvement of agricultural research, food policy and the lives of the poor. The World Food Prize also honored Nobel laureate, Dr. Norman Borlaug, whose earlier work sparked the Green Revolution, and who is a leading advocate of agricultural biotechnology.

The Plant Sciences Institute is also interested in contributing further to the World Food Prize Youth Institute and Youth Summer Internship Abroad Program. These programs are enormously enriching experiences for Iowa high school students.

It is a pleasure for the Plant Sciences Institute to join the World Food Prize in honoring distinguished scientific leaders and in serving the young people of Iowa.

Stephen Howell
Director

Metabolomics research lab established

A $1 million grant from the W. M. Keck Foundation will help establish a laboratory for research in the new area of metabolomics.

The grant, along with $1.3 million from the university, will enable Iowa State to set up and operate a world-class facility for the development and use of new, high-throughput technologies to study metabolism in plants.

Metabolism refers to the process by which plants use sunlight as an energy source to combine simple raw materials and produce biological chemicals. Metabolomics is a new term that describes the science of metabolism studied by using the new tools of genomics.

Metabolomics research in plant and crop species holds the promise of improving food production technologies, reducing the environmental impact of agricultural practices and advancing the development of

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Plant Sciences Institute

Gift will establish new genomics laboratory

When completed in the spring of 2003, the Roy J. Carver Co-Laboratory will house several research labs. Foremost will be the Pioneer Hi-Bred Genomics Laboratory, established through a gift of $100,000 from the Iowa-based company, Pioneer Hi-Bred International, Inc.

The laboratory will house the latest genomic technologies, which will be used to train graduate students and early-career scientists in an environment that emphasizes creative thinking, said Patrick Schnable, who directs the Center for Plant Genomics and will oversee the lab.

"Exposure to high-throughput equipment will enable students to explore new ideas and think in new ways about what research can and should be done," he said. "Graduates will be better prepared to make significant contributions in their chosen fields."

The laboratory also will facilitate exchange of ideas among the brightest academic and industry scientists and will advance research in biochemistry, genomics, analytical chemistry and maize genetics. "The lab will help us to better understand plant genetics and thereby produce substantial benefits worldwide," Schnable said.

"Pioneer Hi-Bred's generosity in establishing this lab puts us one step closer to being a world leader in plant genomics research," Schnable said.

Bioinformatics center director named

Robert Jernigan has been named director of the Plant Sciences Institute's Laurence H. Baker Center for Bioinformatics and Biological Statistics, effective March 1, 2002.

Jernigan is chief of the Section on Molecular Structure and deputy chief of the Laboratory of Experimental and Computational Biology at the National Cancer Institute, National Institutes of Health.

Jernigan earned his doctorate in chemistry at Stanford University, studying under Nobel laureate P. J. Flory. He joined NIH in 1970 as a senior staff fellow and became a theoretical physical chemist in the Laboratory of Experimental and Computational Biology in 1975. He was named deputy chief of the laboratory in 1980 and section chief in 1992. Jernigan is a fellow of the American Association for the Advancement of Science and a member of the editorial advisory board of the journal, *Biochemistry.*

Metabolomics lab established/CONTINUED

biorenewable, environmentally safe sources of industrial chemicals.

"The Keck Foundation grant will make it possible for us to use state-of-the-art equipment to identify gene functions and improve our functional view of plant metabolism," said Basil Nikolau, who heads the Center for Designer Crops, which will oversee the lab's operation.

To identify the detailed physiological functions of the genes that comprise the entire genetic blueprint of an organism, the contribution of each gene of a genome must be determined at all potential levels of expression—mRNA, protein and metabolite.

"Iowa State's existing laboratories allow scientists to profile genome-wide expression at the mRNA and protein levels," Nikolau said. "The new Metabolomics Research Laboratory will enable profiling at the metabolite level, giving us the ability to functionally analyze the operation of the entire genome at multiple levels."

The laboratory will bring together three groups of Iowa State researchers: chemists with expertise in micro-chemical analysis, engineers with expertise in the development of microelectromechanical systems (MEMS) devices, and plant biologists with expertise in functional genomics of plant metabolism.

Ph.D. student Ann Perera uses a GC mass spectrometer to profile metabolites. The new metabolomics lab will enable research not previously possible at Iowa State.

"The chemists and engineers will develop enabling technologies that will be used by the plant biologists in functional genomics research," Nikolau said. "The new lab will impact existing research and enable research not currently possible at Iowa State."

News Briefs

Interim director of bioinformatics center named

Hal Stern, Iowa State professor of statistics, has been named interim director of the Laurence H. Baker Center for Bioinformatics and Biological Statistics. Stern, who is a Fellow of the American Statistical Association, was on the faculty at Harvard University for seven years before joining Iowa State's faculty in 1994. He earned his Ph.D. from Stanford University in 1987. He succeeds James Cornette who retired in May. A national search for a permanent director will begin soon.

Three new faculty hired

Xiaoqui Huang (Ph.D., Pennsylvania State), associate professor of computer science, will analyze DNA sequences and develop computer programs for plant genome research in the Laurence H. Baker Center for Bioinformatics and Biological Statistics. He was on Michigan Technological University's faculty for nine years. Most recently, he was associate professor at the Keck Graduate Institute of Life Sciences and a principal scientist at Paracel Inc. in California.

Nicola Pohl (Ph.D., University of Wisconsin), assistant professor of chemistry, researches in the area of reductive chemistry of carbohydrates. She will work on using crops for biobased industrial products in the Center for Crops Utilization Research. Pohl was National Institutes of Health (NIH) Postdoctoral Fellow at Stanford University for three years.

Steve Whitham (Ph.D., University of California), assistant professor of plant pathology, will research host genes involved in supporting or restricting virus infections at the Center for Plant Responses to Environmental Stresses. From 1996 to 1999, he was NIH Postdoctoral Fellow at the Institute of Biological Chemistry. For the past year, he was a staff scientist at Novartis Agricultural Discovery Institute.

Scanes speaks on GMOs in England

In August, institute interim director Colin Scanes gave an invited talk on genetically modified organisms to the Royal Agricultural Society of England. The society is an independent charity devoted to the advancement of British agriculture. The audience included farmers, legislators, environmentalists and scientists. Scanes also was featured speaker at a luncheon of journalists at the U.S. Embassy in London.

Six graduate fellows named

The institute awarded excellence fellowships to six new graduate students this fall. The fellowship provides a one-year $20,000 stipend plus tuition, and a supplement for three additional years. The students, their previous school and their area of study are: Heidi Kratch (University of Wisconsin), horticulture; Xu Li (Peking University), biochemistry, biophysics and molecular biology; Joseph Robins (Utah State University), genetics; Shannon Schlueter (Texas A&M University), bioinformatics computational biology; Chang-Hui Yan (Peking University), bioinformatics computational biology; and Fei Yu (Chinese Academy of Science), interdepartmental plant physiology.

Laboratory enables cutting-edge proteomics research at Iowa State

Iowa State's proteomics instrumentation facility is one of only a handful of university labs nationwide dedicated to proteomics, the analysis of the protein complement of the genome. About 10 research groups are using the one-year-old laboratory.

"Genomics gives us the cookbook and proteomics allows us to use the recipes," said Parag Chitnis, biochemistry professor. "Proteomics is the next step, we're using genome sequences to understand its function. Proteins perform the function—they're ultimately responsible for traits."

In the ISU facility, a Voyager DE Pro MALDI-TOF mass spectrometer is used for high-throughput peptide mass fingerprinting to identify proteins. It provides proteome analysis opportunity for accurate mass determination and for fragmentation with post-source decay.

The proteomics facility makes possible research that otherwise could not be undertaken at Iowa State, including:

- an examination of changes of protein in the corn proteome during low temperatures, which pose serious problems for young corn seedlings;
- analysis of the differences that occur in the genome expression in developing soybean seeds stressed by high temperatures; and
- identifying the proteins expressed in response to diseases like soybean cyst nematode.

Recent research grants

Functional analysis of plant MAPK cascades in stress and hormonal signaling
National Science Foundation—$536,713
(K. Wang, agronomy)

The genetic basis of winter hardiness in alfalfa
U.S. Department of Agriculture—$365,000
(C. Brummer, agronomy)

Mutational analysis of photosystem I function
National Science Foundation—$262,450
(P. Chitnis, biochemistry, biophysics and molecular biology)

Function of the maize starch synthase zSSIII/DU1 in amylopectin biosynthesis
Department of Energy—$171,000
(A. Myers, biochemistry, biophysics and molecular biology)

Collaborative project for identifying and characterizing corn lines for commercial applications
Iowa Corn Promotion Board—$167,620
(J. Jane, food science and human nutrition)

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Institute funds five Iowa State research projects

The Plant Sciences Institute has awarded five research grants to Iowa State faculty. Each project receives funding of $25,000 per year for two years. The projects are described below.

Computational methods for gene expression data to understand the actions and interactions of genes

D. Ashlock, mathematics; P. Becraft, zoology and genetics; J. Dickerson, electrical and computer engineering; and E. Syrkin Wurtele, botany

The researchers will develop powerful, user-friendly software packages to analyze vast amounts of data harvested at Iowa State through molecular technologies such as RNA and protein profiling. The approaches developed will be integrated visualization tools to create a Gene Expression Toolkit, a complete analysis system capable of adding other larger biological data sets as technologies evolve.

Development of an RNA virus vector for high-throughput gene function analysis in cereals

W. A. Miller, plant pathology

A limiting factor in functional genomics research is the ability to analyze gene function at the whole-plant level in a high-throughput way. To solve that problem in barley, maize and other cereals, Miller will develop a method in which just a fragment of a gene can be inserted in a viral genome, which is then rubbed on a plant. The ensuing viral RNA replication induces the host plant to shut off expression of its own copy of the gene. The result will be a valuable research tool that enables rapid knockout of cloned genes with unknown functions.

Innovative tools for proteome analysis

P. Chitnis, biochemistry; R. S. Houk, chemistry; and S. Kothari, electrical and computer engineering

Researchers will develop high-throughput methods to characterize post-translational modifications or ion-binding abilities of separated proteins, thereby enhancing the power of proteomics. They will develop experimental and computational tools for global analysis of changes in the corn proteome.

Gene expression in polyploids

J. F. Wendel and R. C. Cron, botany

Nearly all higher eukaryotes contain redundancy in their genomes, due primarily to a process of genome doubling called polyploidy. Although many of the world's most important crops—including maize, wheat, soybean and cotton—are polyploids, virtually nothing is known about expression of genes doubled by polyploidy. Researchers in this project will use species of the cotton plant to provide the first substantive examination of duplicate gene expression in polyploids. They will study the expression of approximately 20 pairs of genes duplicated by a polyploid speciation event one to two million years ago.

A high-throughput, integrated, continuous-flow, nano-liter-scale PCR system for the analysis of plant genomes

S. Chen, industrial and manufacturing systems engineering, and P. Schnable, agronomy

Cost and throughput limitations associated with current genotyping technologies limit the scope of research. This collaboration between a biologist and a microfabrication expert will lay the groundwork for developing a revolutionary nano-technology device that will utilize micro-electro-mechanical systems (MEMS) technology to conduct high-speed, low-cost, high-throughput, accurate and sensitive polymerase chain reaction (PCR)-based genotyping.

Recent research grants/CONTINUED

Structure and function of the cotton genome: An integrated analysis of the genetics, development and evolution of the cotton fiber

University of California-Davis—$160,053
(J. Wendel, botany)

Computational methods for functional and comparative genomics

National Institutes of Health—$144,500
(X. Gu, zoology and genetics)

Bioinformatic tools for extraction and modeling of signal transduction networks

The Procter & Gamble Fund—$128,871
(D. Ashlock, mathematics)

Plant Sciences Institute UPDATE

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The Plant Sciences Institute at Iowa State University, which consists of nine research centers, is supported through public and private funding. It is dedicated to becoming one of the world's leading institutes for plant science research, education and unbiased research-based information. Researchers are seeking fundamental knowledge about the functioning of plants. They are developing ways to help feed the growing world population, strengthen human health and nutrition, improve crop quality and yield, foster environmental sustainability and expand the uses of plants for biobased products and bioenergy. The work of the Plant Sciences Institute is expected to have economic benefits in Iowa and around the world.

Visit us on the Web at **http://www.plantsciences.iastate.edu/**

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Plant Sciences Institute
112 Office and Laboratory
Ames, Iowa 50011-3020